ROOM TEMPERATURE CONTROL USING ON-OFF CONTROLLER

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Room temperature control using on-off controller

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CERTIFICATE

This is to certify that the work in the thesis entitled **Room temperature control using on-off controller** by ***Rajeev kumar*** bearing the Roll No. **112EE0238,** is a record of an original research work carried out by him under my supervision and guidance in partial fulfilment of the requirement for the award of the degree of ***Bachelor of Technology*** *in electrical* ***Engineering***. Neither this thesis nor any piece of it has been submitted for any degree or scholarly honour anywhere else.

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July 8th, 2016

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ABSTRACT

The objective of the project is to maintain the temperature of a room constant using on-off controller. In this project, a control logic is developed and implemented using electronics components. The room is made of aluminium sheet. The logic circuit drives the bulb and exhauster fan fitted in the room. The bulb is used to heat the room, and the exhaust fan is used to cool the same. The temperature of the room is measured with TMP 103 sensor. The room temperature from the sensor is compared with a set value given from a potentiometer .Depending on the compared value the logic circuit decides its control action to be taken, and the overall system becomes a feedback control system. If the set point value is above the sensor measured value, the bulb is turned on and at the same time fan is turned off to increase temperature. If the temperature measured is above the set point then bulb is turned off and fan is turned on decrease the temperature.

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CHAPTER 1

INTRODUCTION

1.1 OVERVIEW

Nowadays, all process control are on-off controller. It became standard and important tool of every control engineering controller, works in energy production, transportation and manufacturing. In present time, all the on-off controller based on microprocessor with the help of PID controller. It gives the accurate value of control element and controls the temperature. So, it is used as temperature controller in control system. It controls the temperature difference between actual temperature and desired temperature. It controls the temperature by using on-off controller in closed loop .There is a temperature sensor which plays important part in on-off controller. Temperature sensor such as a thermocouple or thermistor as input/output.

There are following items to be considered for selection a controller

(i) Type of input temperature sensor and range of temperature.

(ii) Type of output element(solid state relay, isolator)

(iii) Controllers(on/off, proportional, PID)

1.2 ON-OFF CONTROLLER

In this project on-off controller used to control the temperature .It gives the output to device either switch on or off. In this project a fan and a Bulb used in a room. A Bulb is used for heating and a fan is used for cooling purpose. When the temperature decreases below the set temperature point by using temperature sensor. Then Bulb glows but at the same time fan turns off for cooling purpose, when temperature increases above the set point. Then the temperature sensor detects it and fan turns 'on'. The main function of on-off controller is that it compares the actual temperature with its set point and produces an output which will always maintain the set point with the help of sensor.

1.3 IMPORTANCE OF TEMPERATURE CONTROLLER

Temperature control is very important because it from damaging, burning instrument. It protects the instruments against overheating problems and Saves the energy which is lost in form of heat energy. It helps in maintaining the efficiency of instrument. Nowadays wireless temperature monitoring method is more convenient and trouble free than other convenient methods.

1.4 ADDER (SUMMING AMPLIFIER)

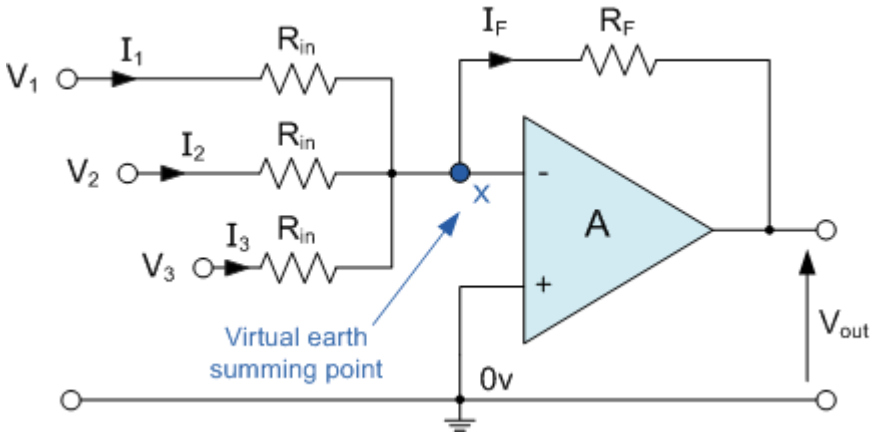
1.4 ADDER

The Summing Amplifier (adder) is able to effectively "Add" or "Sum" together several individual input signals .The output voltage is proportional to sum of input voltage V1, V2, and V3.

The new input

$$I_F = I_1 + I_2 + I_3 = -\left[\frac{V1}{Rin} + \frac{v2}{Rin} + \frac{v3}{Rin}\right]$$

Then $$-Vout = \left[\frac{R_F}{R_{in}} V1 + \frac{R_F}{R_{in}} V2 + \frac{R_F}{R_{in}} V3\right]$$



ADDER CIRCUIT (Figure-1)

For the output voltage is given as

$$-Vout = \frac{R_F}{R_{IN}} (V1 + V2 + V3 \ldots\ldots\ldots etc)$$

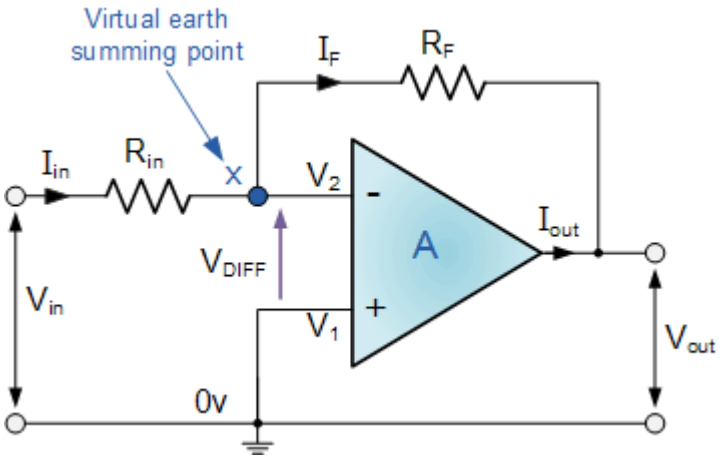
When all the resistances are of equal value, i.e Rf is equal to Rin. Then a direct voltage addition can also be obtained. The equation are

$$-Vout = V1\left(\frac{R_F}{R_1}\right) + V2\left(\frac{R_F}{R_2}\right) + V3\left(\frac{R_F}{R_3}\right) \ldots\ldots\ldots etc$$

If input resistors R1, R2, R3 at equal unity gain then Inverting adder can be made. But if input resistor have different value then adder is produced which gives sum of input signal.

1.5 INVERTERING AMPLIFIER

INVERTER



INVERTER CIRCUIT (Figure-2)

There are two important rules for inverting amplifier

1).If no current flow through input terminal for ideal condition

2).V1 = V2 = 0 (Virtual Earth)

By using these two rules

We can derive the equation for calculating the closed-loop gain of an inverting amplifier, using first principles. Current (i)

$$I=\frac{Vin-Vout}{Rin+Rf}$$

Therefore $$I=\frac{Vin-V2}{Rin}=\frac{V2-Vout}{Rf}$$

So $$I=\frac{Vin}{Rin}-\frac{V2}{R\,in}=\frac{V2}{Rf}-\frac{Vout}{Rf}$$

$$\frac{Vin}{Rin}=V2\left[\ \frac{1}{Rin}+\frac{1}{Rf}\right]-\frac{Vout}{Rf}$$

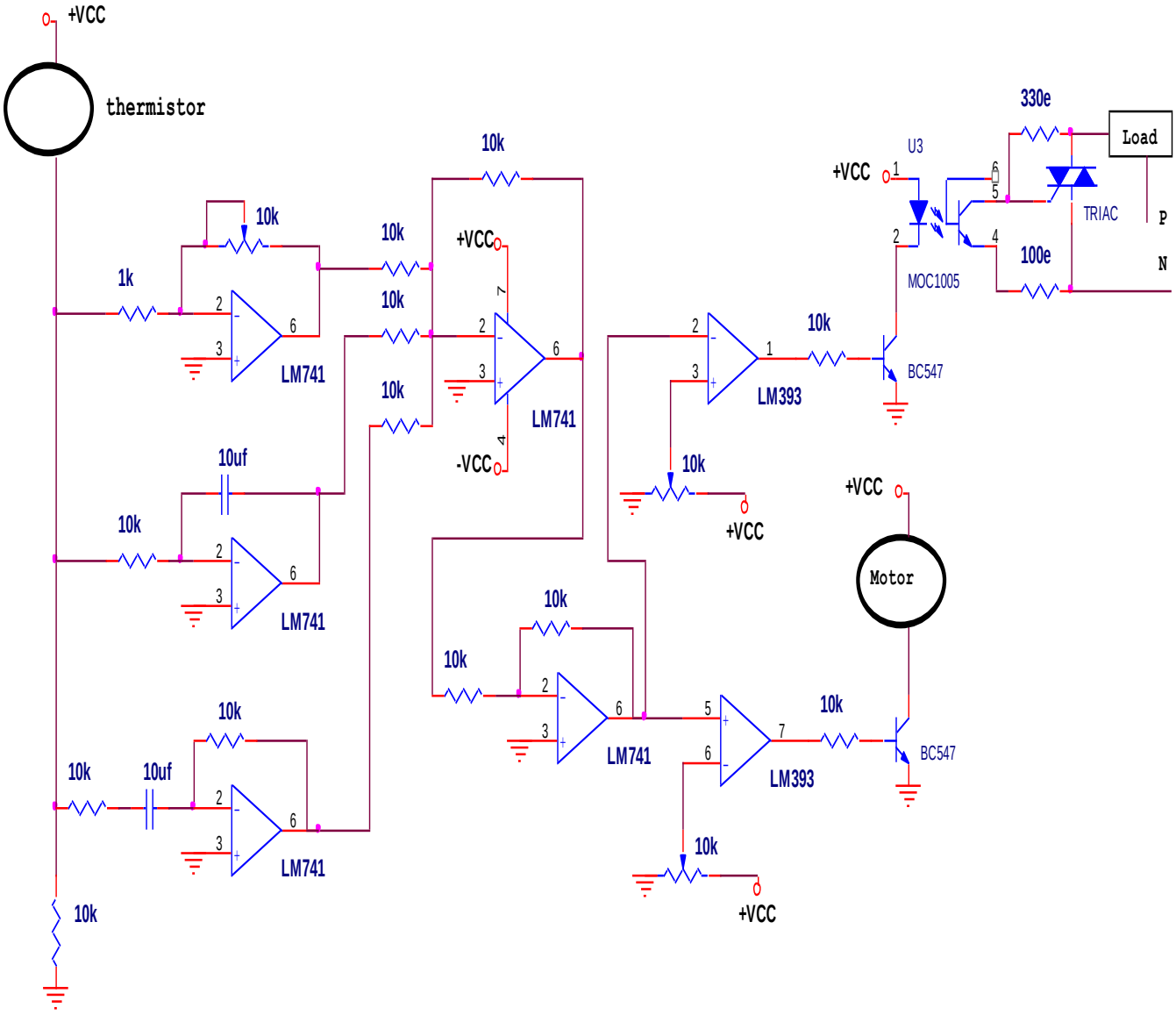
$$I=\frac{Vin-0}{Rin}=\frac{0-Vout}{Rf}$$

$$\frac{Rf}{Rin}=\frac{0-Vout}{Vin-0}$$

The closed loop gain is

$$\frac{Vout}{Vin}=\ -\frac{Rf}{Rin}$$

Where negative sign indicate that output signal with respect to input is 180^{o} out of phase.



CIRCUIT DAIGRAM OF PANEL BOARD (Figure -3)

CHAPTER 2

DESCRIPTION OF PROJECT KITS

2.1 CENTRE TAP TRANSFORMER

CENTRE TAP TRANSFORMER (Figure-4)

12 VOLT DC COOLING FAN (Figure-5)

2.2 POWER CIRCUIT

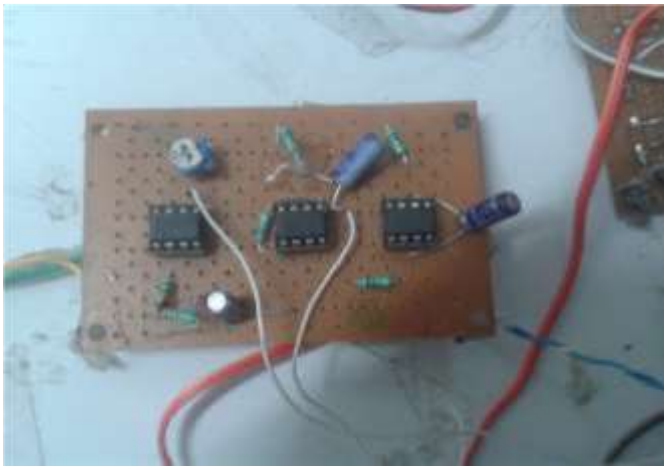
It consists of Transformer, bridge rectifier, voltage regulators namely 7812 and 7912 followed by filter circuit. The transformer used is 230/12volts.The AC supply voltage of 230 is fed to the transformer which whose output is 12V AC. This 12V is fed to the Bridge rectifier which converts the voltage from AC to DC. This voltage obtained is filtered

using capacitors. The output from the filter is fed to the regulators 7912, 7812 whose output is+12 Volts and-12Volt respectively. This is used as +Vcc and –Vee for an Operational amplifiers used in the circuit.

POWER CIRCUIT (Figure-6)

2.3 PID CIRCUIT

This circuit consists of op amps. The op amp is use to design the proportional, integral and derivative analog controller. The input to the op amp consist of two voltages one is the variable voltage fed from the sensor as feedback and other is the fixed value taken as reference. The difference between these two inputs is taken as error. The error is fed to proportional integral and derivative block. Where the error is multiplied with proportional gain in P block and error is multiplied after integrating in I block and the error is multiplied after differentiating in D block. The output of these three blocks or circuits is added up using a summer circuit. The output of the summer circuit is fed to the diode IN4007 .The diode is connected in series with the relay. The output terminals of the relay is connected to the bulb.



PID CIRCUIT (Figure-7)

2.4 ADDER/INVERTER CIRCUIT

This circuit is used for adding output which comes from P, I and D block. After addition it fed to inverter circuit to making positive. This positive value is taken by comparator to compare the signal.

ADDER/INVERTER (FIGURE-8)

2.5 DRIVER CIRCUIT

This driver circuit containing two potentiometer, comparator, Triac, motor driver and opto-isolator. Two potentiometer is use for changing the reference of bulb and fan. Triac which is used in this circuit as a switch when comparator signal gives over voltage Bulb is off at the same time fan is on with the help of motor driver. Optoisolator is used to giving light signal to Triac for switching operation.

DRIVER CIRCUIT (Figure-9)

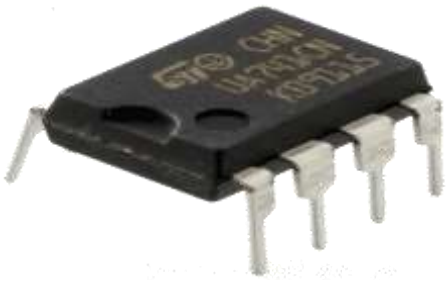
2.6 SENSOR

The sensor used is TMP 103 which is a heat sensor consisting of three terminals such as input, output and ground respectively .This sensor is output is amplified using op amp and the output is fed as feed back to the input terminal of op amp which is compared with the reference value and the sensor sense the temperature.

CHAPTER 3

COMPONENT DETAILS

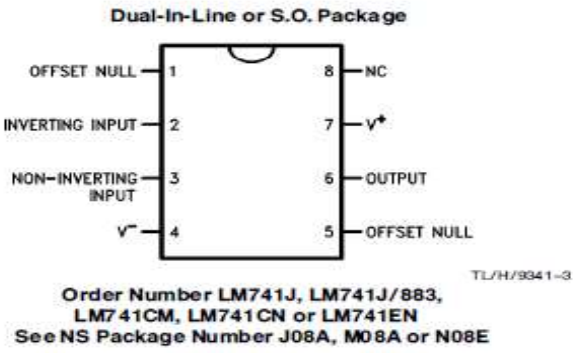
3.1 IC 741 (OPERATIONAL AMPLIFIER)



IC 741(Figure-9)

DESCRIPTION

Operational amplifier are used in many linear, non-linear and frequency-dependent circuits. Feature of a circuit using an IC 741 are set by external components with little dependence on temperature changes and variations in the op-amp itself, so to this characteristics op amp make a popular building blocks of any circuit design. Today in electronic device op amp are mostly used in field like consumer, industrial, and scientific devices. The LM741 series are used for operational amplifiers which feature improved performance over circuit design instead of LM741 other Ic used in most application like LM201/LM709C etc. The amplifiers action has many characteristics which make their function nearly fool proof: like overload protection and it also free from fluctuation. The LM741C/LM741E are identical to the LM741/LM741A have their capability over a $0^{o}C$ to a $70^{o}C$ temperature range.



Pin diagram of IC 741

Specification:

Supply voltage = -15V to 15V

Temperature range = 0°C to 70°C

3.2 TEMPERATURE SENSOR (TMP 103)

The temperature sensor (THERMISTOR) one end of the terminal of the thermistor is connected to a positive and the other end terminal is connected to the ground with a series connected resistances, which forms a voltage divider network. According to temperature increase voltage appear at the output. If the temperature increases the corresponding voltage will increase according to the increase in temperature. That output signal is given to the comparator for comparing the voltage.

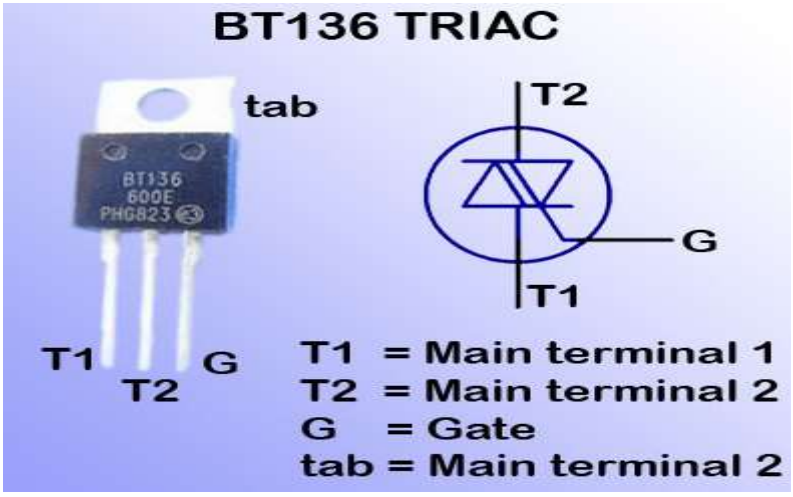
TMP 103 (Figure-10)

Specification:

Supply voltage in range = -1.4 to 3.6V

Temperature range= -40°C to 125°C

3.3 SOLID STATE RELAY –BT136



BT-136(Figure-11)

DESCRIPTION

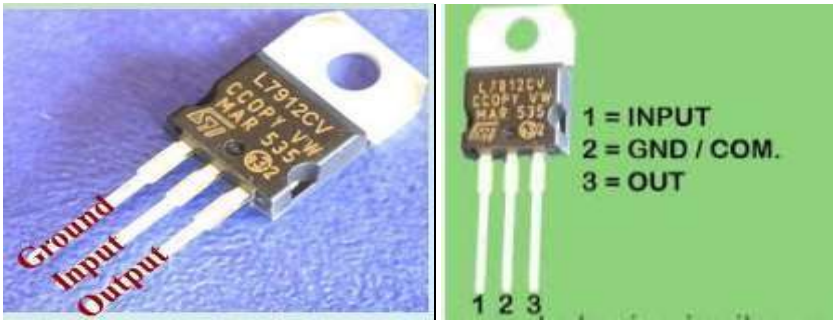
A relay is an electrically operated switch.Triac has three terminal ac switch which is used for conduction, when a small energy signal is applied to its gate terminal the Triac is different From SCR that either a positive or negative gate signal trigger used for conduction. Thus, the Triac has a three terminals, four layer bidirectional semiconductor device which controls ac power whereas SCR controls dc power or forward biased half cycle of ac in a load. Due to bidirectional conduction property the Triac is mostly used in power electronics for controlling purpose. Tri indicates that it has three terminal and ac indicates that it controls ac current.

Specification;

Voltage trigger (max) = 1.5V

Current hold (max) = 15milliampere

3.4 VOLTAGE REGULATORS (7912, 7812)



7912 Figure-12 7812

DESCRIPTION

A voltage regulator is used to maintain constant voltage level in power supply circuit board. In this project two types of voltage regulator is used to maintain the voltage level in positive power supply and negative power supply. LM7812 represents the output voltage series indicates positive voltage regulator and other LM7912 represents the output voltage series indicate negative regulator for power supply. The output remains same within this range of voltage. The negative regulator works in a satisfactory manner between the voltage -(xx+2) to -12V DC. The positive regulator works in a satisfactory manner between the voltage -(xx+2) to +12V DC.

Specification;

Voltage Regulator 7912

Output voltage=-5V,-6V,-9V,-12V

Output current=1A

Voltage regulator 7812

Output voltage =5V,6V,9V,12V

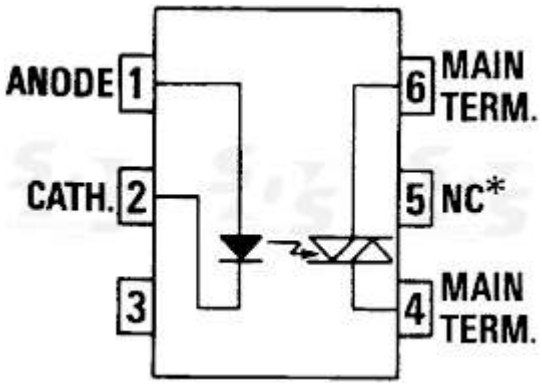
Output current=1A

3.5 OPTOISOLATOR TRIAC DRIVER (MOC 3021)

MOC-3021(Figure-13)

DESCRIPTION

Here in this section, to activate/deactivate the load a solid state device is used to drive the load but the load is an ac load for that we have to isolate that for that we have used an opt-isolator (MOC3021) as a driver. It is an electronics device which isolates between input to output, that device is consisting of a LED and a Triac which is fabricated on a single chip. Whenever a high voltage is given as input to the LED. The LED gets forward biased which in turn on the LED, the light falls on the Triac which in turn the Triac thus gets a sufficient current to drive the gate of the Triac to make turn on the load.



PIN DAIGRAM

Specification:

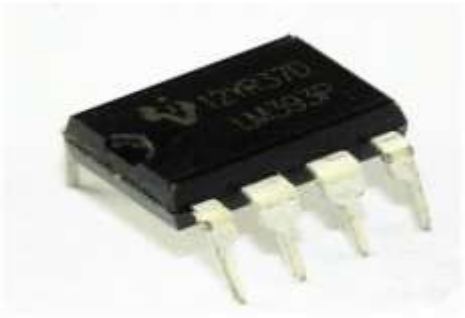
Maximum rating in 25°C in free air

Input to output peak voltage = 7.5kV

Input reverse diode voltage = 3V

Input diode forward current = 50 mill ampere

3.6 COMPARATOR (BA10393)



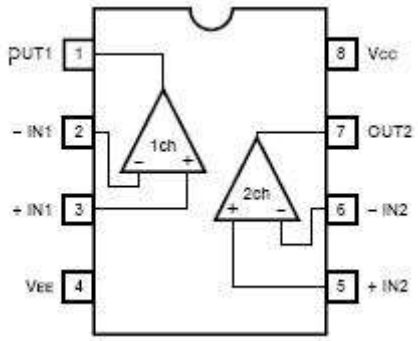
BA-10393(Figure-14)

A comparator is a device containing two input voltage and one output voltage level. The main advantage of comparator is there is no feedback resistor so whatever it compare voltage it give the same voltage in output from input.

The output are

$$V_o = \begin{cases} 1, & \text{if } V_+ > V_- \\ 0, & \text{if } V_+ < V_- \end{cases}$$

A comparator is design to produce limited voltage. It also contain a additional feature such as accurate .internal voltage reference.



PIN DAIGRAM

Specification:

Supply range voltage= ±1.0 Vdc to ±18 Vdc

Low Input Bias Current: 25 nA

Low Input Offset Current: 5 nA

3.7 TRANSISTOR (BD 139)

BD 139 it is npn transistor uses to amplify voltage and current.so it can operate device like lamp, motor or other high current device. It limits the base current so that small current flows through emitter so that limited current flowing to drive the motor and prevent from damage.

Figure-15

Specification;

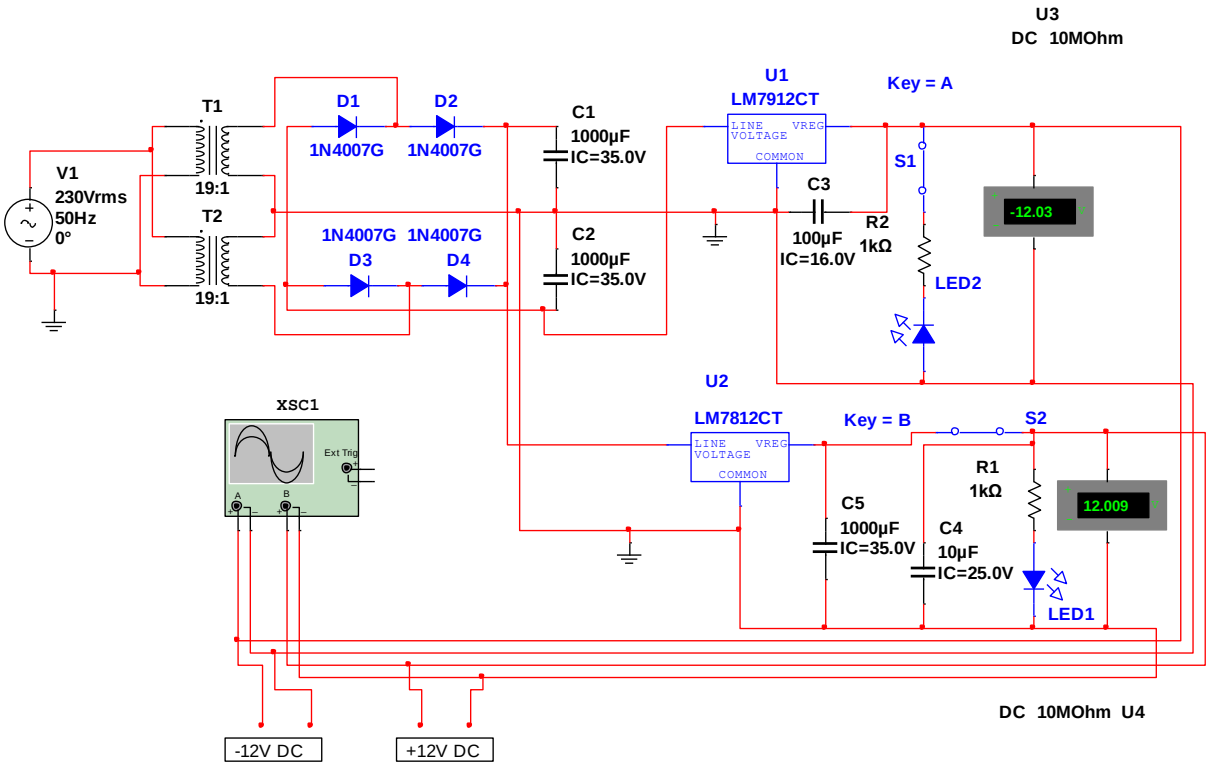
Emitter base voltage=5V

Collector current (dc) = 1.5A

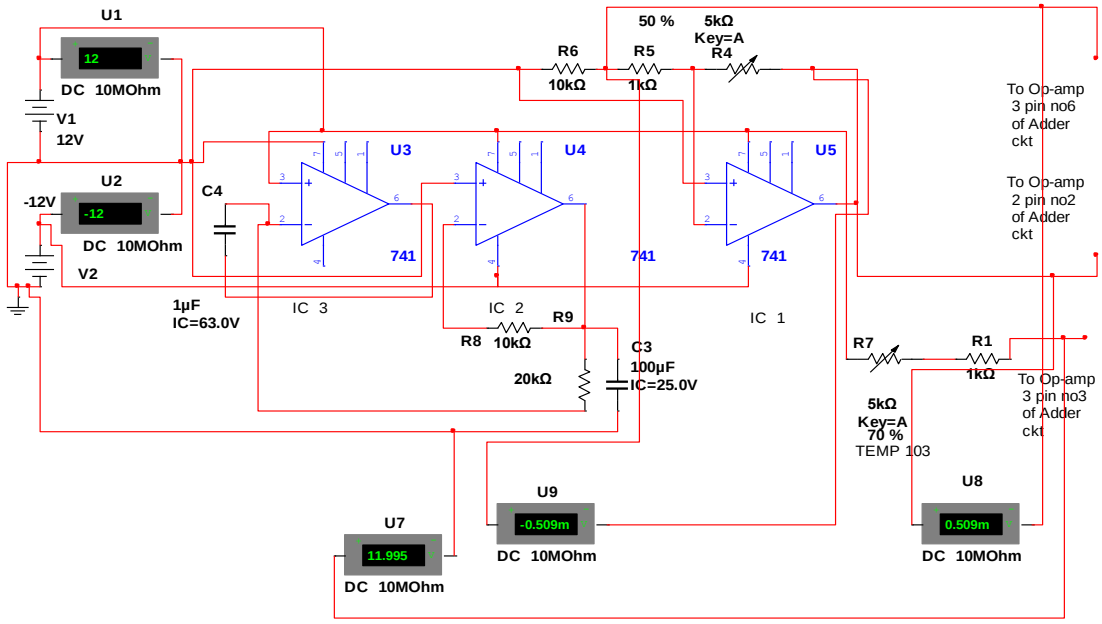
CHAPTER 4

DESIGN OF VARIOUS CIRCUITS IN MULTISIM

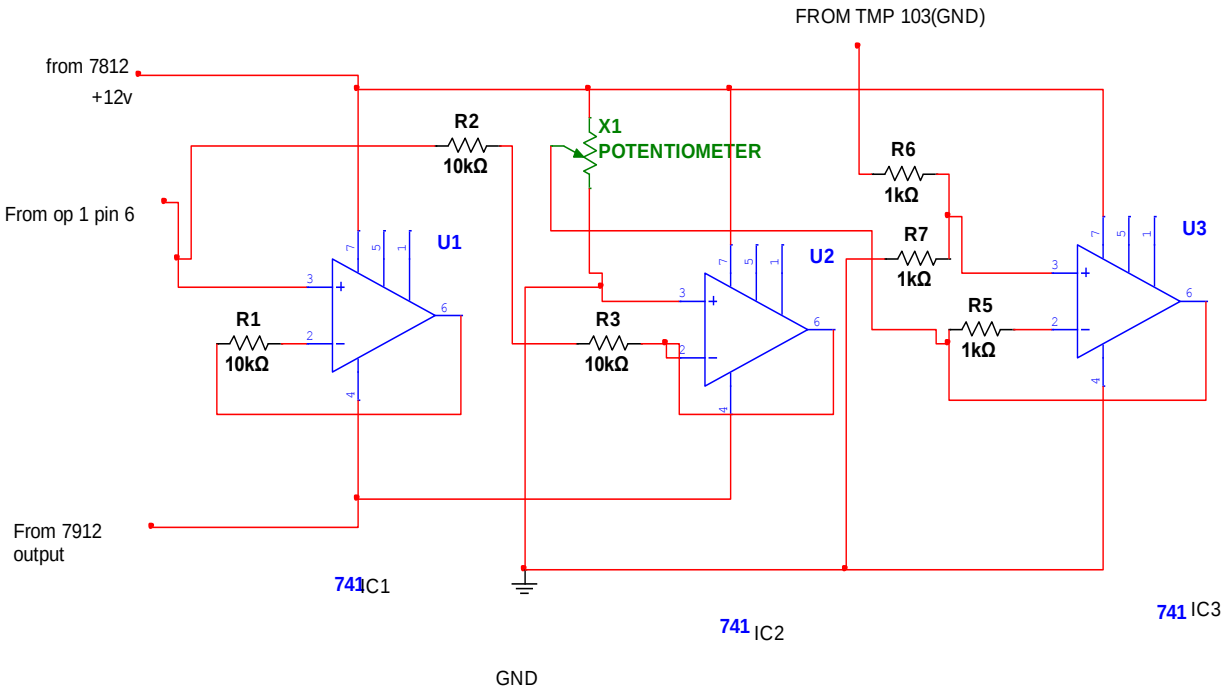
4.1POWER CIRCUIT



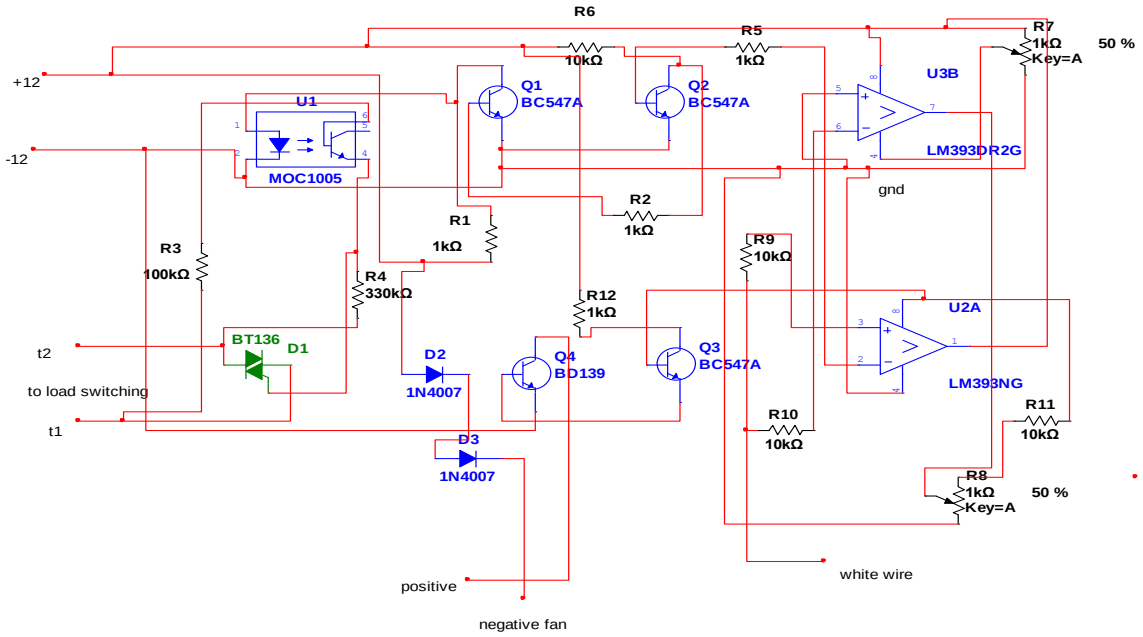
4.2PID CIRCUIT



4.3 ADDER/INVERTER CIRCUI



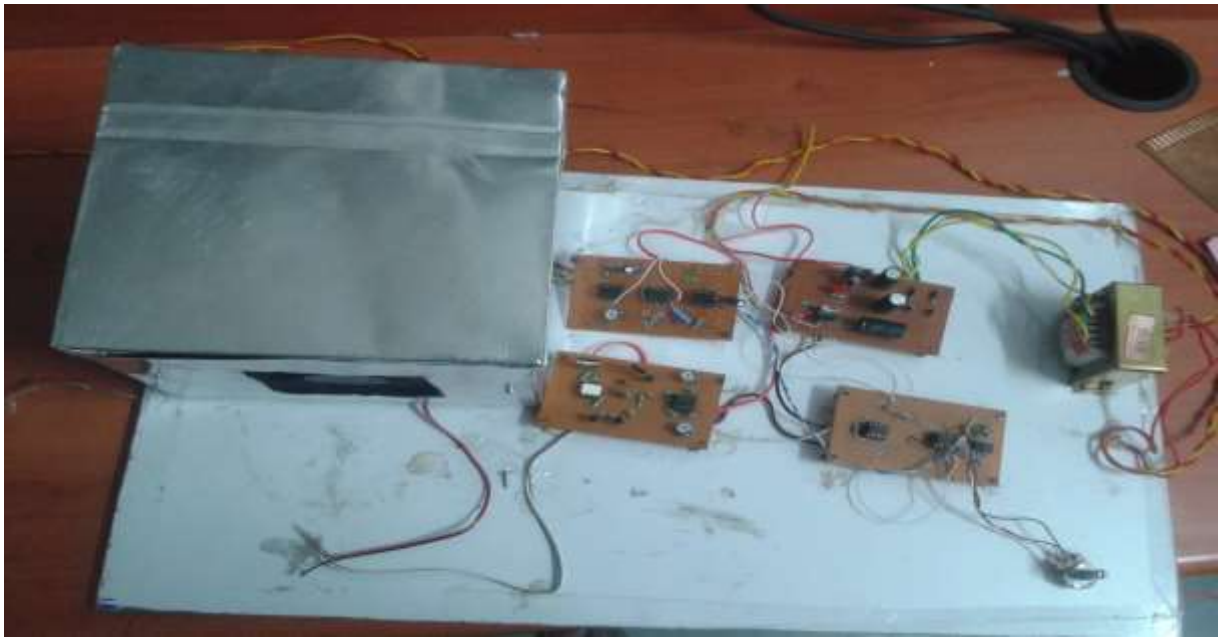
4.4 DRIVER CIRCUIT



CHAPTER 5

RESULT

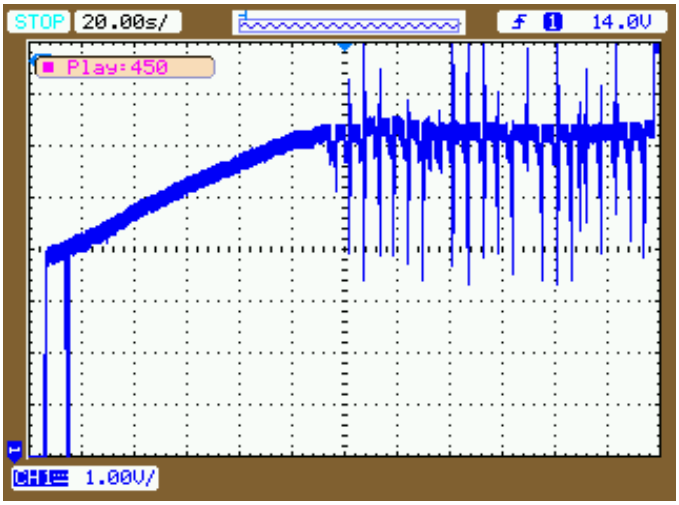
5.1 HARDWARE SETUP



HARDWARE (Figure-16)

5.2 WAVEFORMS FROM OSCILLOSCOPE

Temperature

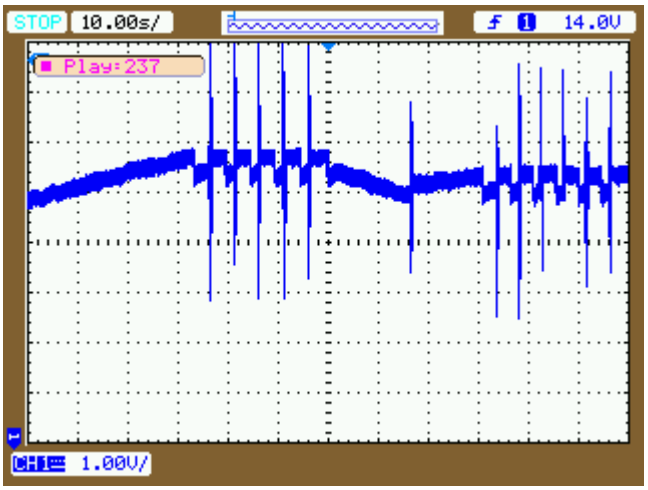


Time

Waveform in increasing temperature in heating process

In this graph with time increase and sensor read the temperature from room and it is converted to respective voltage. It is calibrated that in 1V the temperature of room is almost 27°C.so in this case in 4.1V the temperature of room is about 37.25°C.In this temperature we take a reference.

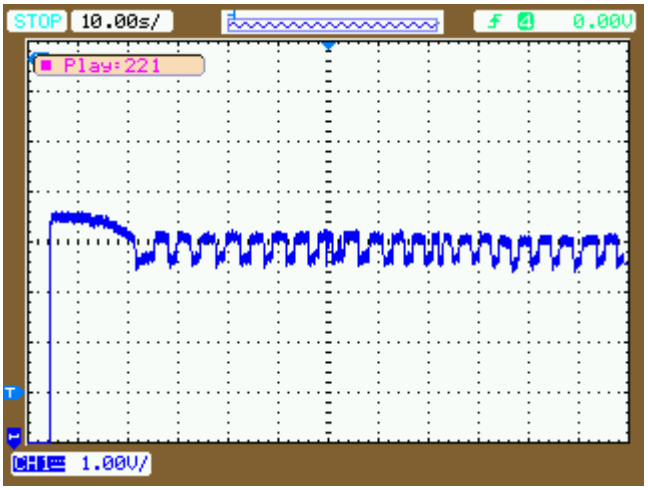
Temperature



Time

Waveform with constant temperature in heating and cooling

Temperature



Time

Output waveform of on-off controller

CHAPTER 6

FUTURE SCOPE

The performance of control system can be increased by combining closed loop control of ON-OFF controller with open loop control. The open loop value can generally provide the major portion of controller output. The ON-OFF controller responds to any difference or error remains between the set point and the actual value. By the feedback process the open loop output is not affected. So it is increasing the system stability and response.

In improvement to open loop ON-OFF controller generally increased by some method as like PID gain scheduling, fuzzy logic etc.

CHAPTER 7

CONCLUSION

The temperature control has become an integral part of any control system operating under temperature sensitive system. In this project, a control logic is developed and implemented using electronics components. Temperature control is achieve by a closed loop circuit in this project. This project gives information about the temperature control in a room. In this project we develop a system which actually control the temperature of room heating as well as cools. Here we used a bulb in room and tried to control surrounding temperature of the room by using heat sensor TMP 103 and fan. ON-OFF controller controller mechanism used in this project. .

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